**Maine Department of Environmental Protection**
**Bureau of Land & Water Quality**
**O&M Newsletter**
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A monthly newsletter for wastewater discharge licensees, treatment facility operators, and associated persons

**Index**



## An Introduction to Wastewater Biology

Continuation of wastewater biology taken from Environmental Training Consultants, 1994, "Activated Sludge Operations for Pulp & Paper Mills"

An important growth pressure is temperature. We have seen how the growth of microorganisms is a direct result of metabolic reactions, most of which are catalyzed by enzymes. As with all chemical reactions, temperature has an effect on the rate of these reactions. As the temperature increases the rate of reaction increases, and thus the rate of cell growth and reproduction increases. As a general rule the rate of microbial growth doubles with every 10$^{o}$C increase in temperature up to a limiting temperature.

At low temperatures, growth declines, although some microorganisms can exist even slightly below freezing. However, at high temperatures they can be killed. This is caused by destruction of the enzyme systems at certain limiting temperatures. Heat destruction of enzymes is called denaturation. The enzyme becomes inoperative because some of the chemical bonds are broken and its three dimensional structure destroyed. The important thing is that the cells die because they are dependent upon the enzymes for essential metabolic reactions.

Most microorganisms do best in moderate temperatures, but there are many different types of microorganisms, and they have different enzyme systems. Some types can tolerate extreme cold or hot, and, in fact, some do best under extreme conditions. Microorganisms can be classified on the

basis of the temperature range in which they have optimum growth.

The majority of microorganisms thrive at 35°C. These organisms are called mesophilic microorganisms. They would die if the temperature reached 40-45°C. Microorganisms which grow best at high temperature (55-65°C) are called thermophilic microorganisms. But even these, with heat-resistant enzyme will die if the temperature rises much above 65°C.

Most microorganisms grow very slowly, if at all, at extremely low temperatures. However, a few organisms can withstand temperatures at and slightly below freezing. These are called psychrophilic microorganisms. Psychrophiles have low rates of growth, thermophiles have high rate of growth and mesophiles are between these two extremes. Remember that growth rate and removal of food from the environment are directly related. Thermophilic and mesophilic microorganisms remove more organic food from the environment faster than psychrophilic microorganisms. This is important to keep in mind in the operation of activated sludge plants as temperature changes from summer to winter. Process control targets for a given plant may be considerably different as ambient conditions change.

The pH of the environment has a profound effect on the rate of microbial growth. As with temperature, the effect is directly on the metabolic enzymes. Acid conditions (low pH) or basic conditions (high pH) can destroy the three dimensional structure of the enzyme and thus stop growth. Most microorganisms do well within a pH range of 6.0 to 8.0, possibly as high as 8.5.

However, as with temperature, some enzyme systems can tolerate extreme pHs and thus some organisms can thrive in acidic or basic environments. Fungi, for example, do well in acidic conditions. Most bacteria and protozoa, however, grow best in neutral pH conditions. Abnormal pH in biological treatment processes can result in a significant decrease in the rate of removal of organic compounds from the environment. It can also select for the growth of unfavorable types of organisms in the treatment process.

Industrial facilities should have the capability to control the pH of the wastewater within an acceptable range before it is mixed with biomass in the aeration basin. Even short term exposure (less than one minute) to extreme pH causes significant microbial destruction.

Dissolved oxygen is a critical environmental factor. As we have seen, the metabolic process differs in the presence or absence of dissolved oxygen. Much has been written and discussed about the proper dissolved oxygen residual for aeration basin operation. The “text book” guidance for proper aeration basin residual is 1-2 mg/L dissolved oxygen. While this may be proper for some facilities, it is not proper for all facilities. As the F/M ratio increased, the dissolved oxygen residual must be raised accordingly.

Very highly loaded plants have found that “low-DO filamentous bulking” occurs even though 1-2 mg/L DO has been achieved. On the other hand, plants operating at a low F/M ratio may perform very nicely at 0.5-1.0 mg/L DO. The best “rule” is to be open-minded about dissolved oxygen and adjust aeration basin residual in accordance with the F/M (organic loading). One of the biggest costs in the operation of an activated sludge plant is the energy required for aeration. Conscientious control of D.O. can pay tremendous economic dividends.

Many of the life processes involve synthesis of new materials within the organisms. New cells are produced as the microorganism reproduces. Molecules within the cells must be replaced as they wear out and break down. These synthetic processes require fundamental chemicals from which to build the more complex biochemicals involved in the structure and function of the cells. The

source of the chemicals is the food particles taken in by the organism. Not only are the organic food particles used as a source of energy, but also a source of chemicals for the synthetic process.

Microorganisms must have a balanced diet, just like humans. The major chemical elements required are carbon (C), hydrogen (H), oxygen (O) and nitrogen (N). In addition, many other elements are required in lesser amounts. These include: phosphorus (P), sulfur (S), sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), iron (Fe), molybdenum (Mo), cobalt (Co), manganese (Mn), zinc (Zn), and copper (Cu). The proper amount of all these elements must be available to the microorganisms. If any are lacking, the organism will not thrive; or in some cases, may not survive.

The nutrient availability and balance also establishes a "competitive advantage" for certain members of the microbial community, particularly when nutrients are limited. This may lead to the growth of nuisance microorganisms which interfere with the settling properties of activated sludge. Poor settling sludge, typically called "bulking," is a common problem in activated sludge facilities. Bulking can be caused by a variety of different microorganisms under a number of circumstances. In addition to causing settling problems, nutrient deficiency may contribute to the production of troublesome scums, foam and excess slime.

Operating experience at numerous wastewater treatment facilities clearly shows the importance of having nitrogen and phosphorus available at the same time and in proportion to the $BOD_5$ loading. In some cases it is necessary to feed nutrients. As a general rule, for each 100 mg/L BOD5, the bugs need 5 mg/L nitrogen and 1 mg/L phosphorous. This is referred to as a C:N:P ratio of 100:5:1.

Nitrogen may be added in one of several forms. It is most readily available to the bugs when fed as ammonia or nitrate nitrogen. Organic forms of nitrogen (except for urea) may not be available to the bacteria quickly enough to properly metabolize the easily degraded carbohydrates and acids, such as those found in pulp and paper, brewery and fruit juice wastes.

Phosphorus is commonly fed in the form of phosphoric acid.

When nutrients are not properly balanced with the $BOD_5$, performance problems occur. $BOD_5$ removal suffers, and poor settling biomass develops. Both filamentous bulking and viscous (slime) bulking are related to nutrient deficiency.

An aeration basin residual of 1-2 mg/L nitrogen and 0.5 mg/L phosphorus is usually sufficient to ensure that the nutrient requirements of the bugs have been met. While a nutrient deficiency can cause serious operational problems, such problems disappear when the required nutrient balance is established.

## Staffing Changes at DEP

Recently two significant changes in staffing have taken place in the Division of Water Quality Management that will affect our wastewater license holders and I wanted to take the opportunity to make everyone aware of them.

First, we have finally been able to fill the pretreatment position vacated when Jim Rogers retired a year ago. I am pleased to announce that Jim Crowley has been selected to fill the position. Jim has a Bachelor of Science Degree in Chemistry from C.W. Post College in Long Island, New York and Jim brings 24 years of industrial and industrial pretreatment experience from various facilities to the job. Most recently, Jim was working for our

Division in our enforcement section. In addition to handling the pretreatment program, Jim will also be the compliance inspector for 14 facilities and will be supervising three other compliance inspectors working out of the central office. Please take the opportunity to introduce yourselves when you get a chance and welcome Jim to his new position. At this time I would like to thank Ken Jones, who has been handling the pretreatment position and the compliance inspector duties for the 14 facilities for the last year and doing a great job for our Division.

Another staff change involves Don Albert. Don has been selected to fill a modeling position in the Division of Environmental Assessment vacated when Dave Miller retired earlier this summer. Don will be evaluating the effects of point and non-point source discharges, hydropower projects and other activities on rivers and streams for attainment of Maine's Water Quality Standards. Don has a Bachelor of .Science in Civil Engineering from the University of Maine and has previously worked in water and wastewater design. He has been at DEP for 24 years where he wrote wastewater discharge permits, conducted numerous pollution prevention projects, and provided training and technical assistance to wastewater treatment facility operators throughout the state for over 20 years. Don's experience and expertise will certainly be missed, but we look forward to working with him in his new role with the Department.

***Sterling Pierce***
***Compliance & Technical Assistance Unit***

## Database Changes at DEP

As you may know, DEP has been storing your DMR data in a database system called the Permit Compliance System (PCS) since the late 1980's. EPA has been planning to upgrade the system for a number of years, and now that is happening. EPA is in the process of implementing their new system called the Integrated Compliance Information System (ICIS). At the same time, Maine DEP is implementing our own new database system called the Environmental Facility Information System (EFIS). This system will eventually hold all of the data from all of the Bureaus here at Maine DEP. We will be connecting this to another system called the Electronic Discharge Monitoring system. By now you are wondering, "Why do I care about any of this computer work?" In the near future, you will be able to submit your DMR data electronically over the World Wide Web. Our inspectors will be able to review your DMR data using their computers and then it will be sent to our new database systems and then to PCS and, eventually, ICIS.

I wanted to update you about these systems because currently we are experiencing some technical difficulties and have not been able to enter DMR information into PCS since early August. By the time you read this, the problems will have been resolved, and we will be back to normal operations. However, this delay may mean that some of you might see a message show up on the Environmental Compliance History Online (ECHO) system, if you check your facility records. We will do our best to rectify any problems that occur as a result of this delay. Thank you in advance for your support and understanding.

***Dick Darling***
***Compliance & Technical Assistance Unit***

## The Hows and Whys of Sanitary Surveys

Malfunctioning septic systems, septic tank overflows and straight pipes continue to negatively impact Maine's coastal and inland waters. It is the statutory responsibility of the Maine Department of Environmental Protection (DEP) to prevent,

abate and control pollution of the waters of the state. Two major areas of concern are public swimming beaches and shellfish harvesting areas. The DEP works closely with both the Maine Healthy Beaches Program (www.mainehealthybeaches.org/index) and the Department of Marine Resources to identify the highest priority areas to work in.

As per Title 38 M.R.S.A. § 413.1, "No person may directly or indirectly discharge or cause to be discharged any pollutant without first obtaining a license therefore from the department." DEP's efforts to identify and eliminate unlicensed discharges of pollutants include the conduct of sanitary surveys. For DEP's purposes, a sanitary survey is a property by property search for domestic wastewater discharging to waters of the State. A sanitary survey is not to be confused with a shoreline survey which is limited to properties along the shore, or a watershed survey which is a comprehensive search for all potential sources of water pollution within a watershed. The former is often too limited in scope, while the latter is generally too large in scope, given the DEP's limited resources and the need to focus primarily on sources of bacteria contamination.

Sanitary surveys are conducted in response to a documented water quality problem such as closure of a shellfish harvesting area or repeated high bacteria scores at a public swimming beach. Before a sanitary survey is conducted, its feasibility must be determined. If the number of potential sources or area to be surveyed is too great, a sanitary survey would be considered unfeasible. To determine its feasibility, the area of the watershed is defined. Next, the approximate number of potential contamination sources is determined. A visit to the area can help to locate and identify areas that need to be searched. Once a survey has been determined to be feasible, tax maps and property owner lists are needed to identify and track specific properties.

The conduct of sanitary surveys by the DEP is relatively simple. The determination is made in the field regarding which properties have a likely potential to discharge to waters of the state. Drainage ditches, streams, and wetlands all serve as hydraulic conduits to beaches and shellfish harvesting areas. In conducting sanitary surveys, DEP staff do not conduct formal septic system inspections. Instead, we try to identify the locations of septic systems and look for any evidence of breakouts. We look for low wet areas, lush vegetation, streams and storm drains, and rely greatly on the sense of smell. Occasionally, we will dye test a toilet or sink if a discharge is strongly suspected but not confirmed. Older homes with septic systems that have not been updated are more often found to be in violation. We identify wastewater disposal problems at an estimated 10%-15% of the properties we visit during sanitary surveys.

It should be noted that municipalities have jurisdiction over enforcement of malfunctioning septic systems. There is overlapping jurisdiction with the DEP, however, for malfunctioning systems that discharge to waters of the state, either ground water or surface water. The DEP will usually work with the Local Plumbing Inspector to correct malfunctioning systems that discharge to waters of the state. Those having unlicensed discharges are subject to enforcement action which may include the imposition of monetary penalties. As a general rule, however, the DEP gives property owners a reasonable period of time to eliminate their discharge and even administers the Small Community Grant Program (www.maine.gov/dep/blwq/docgrant/scgpara2) for those who may qualify for funding to replace their septic system. The DEP encourages municipalities to take a proactive approach to identifying and eliminating malfunctioning septic systems before they become water quality problems and we welcome their assistance at identifying and correcting problems.

Sanitary surveys have resulted in the discovery and elimination of many unlicensed discharges. Surveys conducted in Blue Hill and Cushing have resulted in the reopening of closed shellfish areas and a survey conducted in Lincolnville has resulted in improved water quality at the public swimming area. Sanitary surveys in Waldoboro, Brunswick, Kennebunkport and Biddeford are currently in progress.

***John Glowa***

## *Approved Training*

October 3, 2006 in Bangor, ME - Asset Management & Budgeting – Sponsored by JETCC – (207)-253-8020 – Approved for 6 hours
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October 4, 2006 in Norway, ME – Class II Water Treatment Exam Review – sponsored by MRWA – (207) 729-6569 - Approved for 3.75 hours
*****
October 5, 2006 in Jay, ME - Cured-in-Place Pipe – Sponsored by JETCC – (207)-253-8020 – Approved for 6 hours
*****
October 10, 2006 in Ellsworth, ME – Class III and IV Water treatment Exam Review – sponsored by MRWA – (207) 729-6569 - Approved for 2.5 hours
*****
October 11, 2006 in Belfast, ME – Class II Water Treatment Exam Review – sponsored by MRWA – (207) 729-6569 - Approved for 3.75 hours
*****
October 12, 2006 in Kennebunkport, ME - Sampling Procedures for WWTP Operators – Sponsored by JETCC – (207)-253-8020 – Approved for 6 hours
*****
October 12, 2006 in Caribou, ME – Class III and IV Water treatment Exam Review – sponsored by MRWA – (207) 729-6569 - Approved for 2.5 hours
*****
October 17, 2006 in Easton, ME – Simplifying your Water/Wastewater Process Monitoring – sponsored by MRWA – (207) 729-6569 - Approved for 5.0 hours
*****
October 18, 2006 in Caribou, ME – Verifying your Water/Wastewater Treatment Process – sponsored by MRWA – (207) 729-6569 - Approved for 4.0 hours
*****
October 18, 2006 in Seal Harbor, ME - Working with Your Contract Lab, Sampling Procedures & Data Evaluation – Sponsored by JETCC – (207)-253-8020 – Approved for 6 hours
*****
October 19, 2006 in Kittery, ME – Simplifying your Water/Wastewater Process Monitoring – sponsored by MRWA – (207) 729-6569 - Approved for 5.0 hours
*****
October 20, 2006 in York, ME – Verifying your Water/Wastewater Treatment Process – sponsored by MRWA – (207) 729-6569 - Approved for 4.0 hours
*****
October 26, 2006 in Dixfield, ME – Work Zone Traffic Control – sponsored by MRWA – (207) 729-6569 - Approved for 5.5 hours
*****
November 1 & 2, 2006 in Presque Isle, ME - North Country Convention – Sponsored by JETCC – (207)-253-8020 – Approved for up to 12 hours
*****
November 7, 2006 in Saco, ME - QA/QC of Laboratory Instruments – Sponsored by JETCC – (207)-253-8020 – Approved for 3 hours
*****
November 7, 2006 in Saco, ME - Working with Your Contract Lab & Data Evaluation – Sponsored by JETCC – (207)-253-8020 – Approved for 3 hours
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November 8, 2006 in Waterville, ME - Applying Process Control Techniques to WWTF Operations – Sponsored by JETCC – (207)-253-8020 – Approved for 6 hours
November 14, 2006 in Hallowell, ME - Asset Management & Budgeting – Sponsored by JETCC – (207)-253-8020 – Approved for 6 hours
*****
November 16, 2006 in Brewer, ME - Pump Station Basics, Retrofits & Troubleshooting – Sponsored by JETCC – (207)-253-8020 – Approved for 6 hours
*****
November 28-30, 2006 in Westbrook, ME - O & M of Wastewater Collection Systems *With voluntary NEWEA Exam* – Sponsored by JETCC – (207)-253-8020 – Approved for 15 hours
*****
December 5, 2006 in Winthrop, ME - Filtration Technologies for Effluent Enhancement – Sponsored by JETCC – (207)-253-8020 – Approved for 6 hours
*****
December 7, 2006 in Augusta, ME - Hands-On GIS 101 for Infrastructure Management – Sponsored by JETCC – (207)-253-8020 – Approved for 6 hours
*****
December 14, 2006 in Augusta, ME - Advanced Microsoft Excel – Sponsored by JETCC – (207)-253-8020 – Approved for 6 hours

Note: JETCC stands for Joint Environmental Training Coordinating Committee
MRWA stands for Maine Rural Water Association
MWWCA stands for Maine Wastewater Control Association
NEIWPCC stands for New England Interstate Water Pollution Control Commission
WPETC stands for Wright Pierce Environmental Training Center.

## *For Practice*

1. The laboratory test used to measure the concentration of hydrogen ions in water is called
   a. Turbidity
   b. pH
   c. Alkalinity
   d. oxidation-reduction potential (ORP)

2. The volt is:
   a. the basic unit of electrical power
   b. the basic unit of electrical potential
   c. the basic unit of electrical resistance
   d. the basic unit of electrical current

3. If too much aeration is provided in the aeration basin, what is most likely to happen in the secondary clarifier(s)?
   a. the settling of the activated sludge will improve.
   b. the oxygen uptake will increase.
   c. the sludge will become bulky and hard to settle
   d. there will be small floc particles on the surface of the clarifier

4. A wastewater treatment plant receives waste from domestic users and an industry. The influent flow is 1,750,000 gpd. and the influent BOD averages 185 mg/l. If an average of 0.17 lb/person/day is assumed for domestic waste, what is the population equivalent served by the plant
   a. 12,537
   b. 13,439
   c. 15,883
   d. 34,582

## 10th Biannual North Country Convention to be held in November

The biannual two-day training conference for operators in Northern Maine will be held this year on November 1st and 2nd in Presque Isle. As usual, 12 or more hours of approved training on a variety of topics will be presented over the two days. The North Country Convention has always been well attended by operators from the northern part of the state. It offers not only an opportunity to attend training sessions but also to meet with product vendors and exchange ideas with each other. For more information about the North Country Convention, contact JETCC at 253-8020.

## Fall 2006 Exam

The fall 2006 Wastewater Operator Certification Exam will be given Wednesday -- November 15, 2006 in the usual locations, Portland, Bangor and Presque Isle. Application ***must*** be postmarked on or before Monday, September 25, 2006 or delivered to the JETCC office by Friday, September 29, 2006. Applications can be obtained by contacting JETCC at 253-8020 or by writing to Wastewater Operator Certification Program, c/o JETCC, PO Box 487, Scarborough, ME 04070-0487

## Answers to *For Practice:*

1. b. pH measures the concentration of hydrogen ions in water. Neutral pH (pH = 7) means that there is a balance of hydrogen ($H^+$) ions and hydroxide ($OH^-$) ions in the water. When there are more hydrogen ions, the pH is lower. This is an acid condition. When there are more hydroxide ions, the pH is higher. This is an alkaline condition.

2. b The volt is the unit used to express electrical potential.

3. c. Too much aeration will cause the sludge to become over-oxidized resulting in pin-floc formation. Pin floc do not settle well and will be carried up and over the weirs. Over-aeration may also cause well-formed floc particles to shear, breaking them into smaller clumps which do not settle well.

4. b 1,750,000 gallons = 1.75 MG
   Plant Loading = 1.75MG X 185 mg BOD/L X 8.34 lb/gallons = 2,700 lb/day
   2,700 lb/day / 0.17 lb/person/day = 15,883 persons